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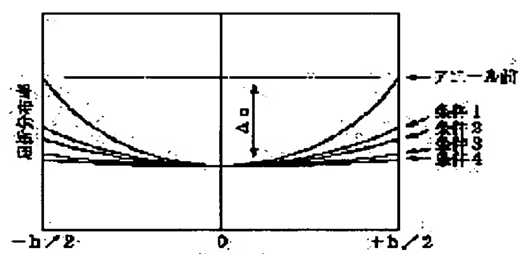
(54) PLASTIC OPTIC AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a plastic optic of good shape accuracy and small birefringence and refractive index distribution to be manufactured at low cost, and also provide a manufacturing method thereof.
SOLUTION: In a molded product formed by the injection compression molding and the like, although the shape accuracy and birefringence are good, the refractive index distribution is generated inside, and an annealing process in which the molded product is heated outside a mold and kept in a temperature zone within the given range for a given time and then cooled is applied to reduce the refractive index distribution in a plastic optic element. As for the annealing condition, in the case the lower limit of the temperature zone within the given range is lower than the glass transition temperature of a plastic material to be used by 25° C, the refractive index distribution is Cv1, while in the case the upper limit is set at the glass transition temperature, the refractive index distribution is Cv4, which are improved better than the refractive index distribution Cv50 before annealing.



アニール前とアニール後の屈折率分布

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CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the plastics optical element characterized by to present refractive-index distribution to the interior, to provide the process which the plastics optical element in below predetermined temperature is heated [process], and raises it to the temperature region of predetermined within the limits, the process which carries out predetermined-time maintenance in the temperature region of said predetermined within the limits, and the process cooled in the appropriate back, to carry out each of said process in above order, and to reduce internal refractive-index distribution.
[Claim 2] The manufacture approach of the plastics optical element characterized by providing the process which carries out predetermined time maintenance of the plastics optical element in the elevated-temperature condition immediately after shaping which presents refractive-index distribution to the interior in the temperature region of predetermined within the limits, and the process cooled in the appropriate back, carrying out said each process in above order, and reducing internal refractive-index distribution.
[Claim 3] The manufacture approach of the plastics optical element according to claim 1 or 2 characterized by for the temperature region of said predetermined within the limits being beyond temperature lower 25 degrees C than the glass transition temperature of the plastic material to be used, and being within the limits below glass transition temperature.
[Claim 4] The manufacture approach of a plastics optical element according to claim 1 or 2 that time amount held in the temperature region of said predetermined within the limits is characterized by being the range of less than 2 hours.
[Claim 5] The manufacture approach of the plastics optical element according to claim 1 characterized by performing said heating process of the plastics optical element which presents said refractive-index distribution, said maintenance process in the temperature region of predetermined within the limits, and said cooling process by batch processing.
[Claim 6] The manufacture approach of the plastics optical element according to claim 2 characterized by performing continuously the forming cycle of the plastics optical element which has said refractive-index distribution and said heating process, said maintenance process in the temperature region of predetermined within the limits, and said cooling process.
[Claim 7] The plastics optical element characterized by having performed heat treatment processing of the predetermined time in the temperature region of predetermined within the limits, and reducing internal refractive-index distribution.
[Claim 8] The plastics optical element according to claim 6 characterized by forming said plastics optical element from thermoplastic amorphous plastic material.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacturing technology of plastic lens ****** especially used for light-scanning systems, such as a copying machine, facsimile apparatus, and laser beam printer equipment, about the manufacturing technology of a highly precise plastics optical element and ******.
[0002]
[Description of the Prior Art] Since surface type-like precision and a precision high to an internal birefringence were required of optical elements, such as a lens and prism, its glass thing was conventionally main. However, the thing made from plastics has been increasing in recent years for the reasons of excelling which are the degrees of freedom and mass-production nature of a configuration. There is improvement in the forming technique which makes possible that the resin ingredient of a low birefringence property was developed as this reason and the mold goods whose configuration precision is a low birefringence well.
[0003] Conventionally, as a resin ingredient used for an optic, although the polycarbonate and the acrylic were main, the birefringence of the polycarbonate was large and, on the other hand, the use range was restricted from the reasons of an acrylic having a problem in absorptivity. However, recently it is low absorptivity as an optic application, and the resin ingredient of a low birefringence property was developed, and application became possible. As such a resin ingredient, there are for example, Nippon Zeon Zeonex, APEL made from the Mitsui petrochemistry, etc.
[0004] Moreover, by using the injection compression molding which fills up resin with low voltage also as forming technique, and applies compression through the whole metal mold or an ON piece, configuration precision is good and the mold goods of a low birefringence came to be obtained. Since it is above, it is in the inclination to continue till recent years and for plastics-ization of an optical element to be promoted further.
[0005]
[Problem(s) to be Solved by the Invention] As mentioned above, although it continues till recently and the optical element of the birefringence property that configuration precision is good and low came to be obtained, the refractive-index distribution inside the optical element after fabrication was large, and there was a problem that it was still inadequate for realizing satisfactory optical-character ability, to a highly precise optical element therefore especially.
[0006] This is explained using drawing 6 thru/or drawing 9 . Drawing 6 is the ** type perspective view of the image formation plastics optical element (image formation lens) used for light-scanning equipments; such as a laser beam printer. Moreover, drawing 7 is a type section Fig. within a perpendicular flat surface at the y-axis of light-scanning equipment. As shown in both drawings, image formation of the beam which penetrated the image formation lens Op in the transparency direction Xv, and it converged after the beam which carried out outgoing radiation from the light sources, such as semiconductor laser, was made parallel by the collimator lens and the deviation scan was carried out by the rotating polygon Plm is carried out on the scan layer Scnf-ed.

[0007] it is shown in drawing 7 — as — configuration precision — good — low — even if it uses a birefringence image formation lens, the lens configuration, the image formation location (design value) f1 for which it asked from the refractive index (it is assumed inside a lens that it is homogeneity) of a resin ingredient, and the location gap have produced the actual image formation location f2.
[0008] When this cause was analyzed, it became clear that it was because the refractive-index distribution to which a refractive index becomes small exists as were shown in drawing 8 , and the refractive index by the side of a lens Op front face was large and it went in the center of lens Op. According to this refractive-index distribution, the operation which a beam emits conversely will work, therefore an image formation location will become far, and an image formation location gap will take place.
[0009] Next, the mechanism which refractive-index distribution produces inside Lens Op is explained. If injection restoration of the resin of a melting condition is carried out into metal mold when such a lens is fabricated with injection molding, the part which touched the low-temperature metal mold wall surface will be cooled momentarily. Drawing 9 is an analysis value which shows the temperature change of the resin in metal mold.
[0010] As compared with a temperature fall near the metal mold wall surface (i.e., a resin periphery part) being steep, the temperature fall of a resin central part is loose. Where the high pressure the time of injection restoration and in early stages of dwelling is cost, it will quench near the metal mold wall and will be in a solid state. Therefore, as for a lens front face, a consistency becomes large. However, since the pressure is declining when the center section of the lens will be cooled and it will be in a solid state, the interior of a lens becomes a low consistency. Consequently, a consistency is as large as a lens front face, and a consistency becomes small, so that it goes to the interior. Since there is high functionality in a consistency and a refractive index, the refractive-index distribution to which a refractive index becomes small will arise, so that a lens Op front face like drawing 8 has a large refractive index and therefore goes in the center.
[0011] As mentioned above, resin may be rapidly cooled near the metal mold wall surface as a main cause which refractive-index distribution produces. Then, the temperature distribution in mold goods were made small by performing annealing to hot metal mold, after carrying out injection restoration of the resin, and the method of obtaining the small lens of refractive-index distribution by this was proposed. However, according to this fabricating method, since the molding cycle was very long, it was a fault that cost becomes very high.
[0012] Furthermore, the lens configuration was specified and the approach refractive-index distribution used a small field was tried. As such a conventional technique, there are some which were indicated with the light-scanning equipment of JP,08-201717,A. According to this technique, it is prescribed in the travelling direction thickness (t: the direction dimension of a x axis of drawing 7) of a beam, and the height (h: the direction dimension of the z-axis of drawing 7) of it and a perpendicular direction that it is set to $h/t>2$ by the lens configuration. It plans that make small the temperature distribution at the time of resin cooling (the direction of the z-axis) in the field which a beam penetrates, and this limited part makes a gap of an image formation location small by enlarging h using refractive-index distribution being small.
[0013] However, since this approach is increasing the part outside the field which a beam's does not penetrate, i.e., a service area, it needs to lengthen a cooldown delay the increment in the required amount of resin, and for surface sink prevention, and serves as cost quantity.
[0014] Moreover, there are some which were indicated in JP,09-49976,A as an approach of performing the optical design which expected refractive-index distribution. This is the approach of Lycium chinense amending the increase (configuration amendment) of the refraction by the side of the scan layer-ed of an image formation lens, and the design value of an image formation location to a rotating-polygon side in the image formation location gap by refractive-index distribution of an image formation lens, and carrying out image formation of the beam on a scan layer-ed. However, when there was fault on shaping etc., for example and there was modification of a process condition since it determines correction value after this approach evaluated the lens which carried out fabrication where a process condition is fixed, it had to change correction

value and had the fault that re-manufacture of a mirror plane piece was needed.
[0015] Moreover, since it is necessary to change correction value for every cavity in the case of the metal mold of picking, only the number of cavities will need to produce much programs for processing. Therefore, there was a fault of becoming cost quantity, by the fault that the number of shaping tries increases very much, the increment in the mirror plane piece production number, etc.
[0016] It was made in order that this invention might solve the trouble in the above conventional techniques, and high degree of accuracy, i.e., configuration precision, is good at low cost, and it aims at offering the manufacture approach to a birefringence and a plastics optical element with small refractive-index distribution.
[0017]
[Means for Solving the Problem] In order to solve said technical problem, the manufacture approach of the plastics optical element concerning claim 1 of this invention The process which presents refractive-index distribution to the interior, heats the plastics optical element in below predetermined temperature, and is raised to the temperature region of predetermined within the limits, It is characterized by providing the process which carries out predetermined time maintenance, and the process cooled in the appropriate back in the temperature region of said predetermined within the limits, carrying out said each process in above order, and reducing internal refractive-index distribution.
[0018] According to the aforementioned configuration, internal refractive-index distribution is reduced, therefore, high degree of accuracy, i.e., configuration precision, is good, and a birefringence and a plastics optical element with small refractive-index distribution are manufactured by low cost.
[0019] The manufacture approach of the plastics optical element concerning claim 2 of this invention is characterized by providing the process which carries out predetermined time maintenance of the plastics optical element in the elevated-temperature condition immediately after shaping which presents refractive-index distribution to the interior in the temperature region of predetermined within the limits, and the process cooled in the appropriate back, carrying out said each process in above order, and reducing internal refractive-index distribution.

[0020] According to the aforementioned configuration, a highly precise plastics optical element is manufactured by low cost and the sex from Takao.
[0021] The manufacture approach of the plastics optical element concerning claim 3 of this invention is characterized by being a thing according to claim 1 or 2, and being beyond temperature with the temperature region of said predetermined within the limits lower 25 degrees C than the glass transition temperature of the plastic material to be used, and being within the limits below glass transition temperature.
[0022] According to the aforementioned configuration, internal refractive-index distribution is reduced, without spoiling the configuration precision of a plastics optical element.
[0023] The manufacture approach of the plastics optical element concerning claim 4 of this invention is a thing according to claim 1 or 2, and time amount held in the temperature region of said predetermined within the limits is characterized by being the range of less than 2 hours.
[0024] According to the aforementioned configuration, internal refractive-index distribution is mitigated for high productivity, without spoiling the configuration precision of a plastics optical element.
[0025] The manufacture approach of the plastics optical element concerning claim 5 of this invention is a thing according to claim 1, and is characterized by performing said heating process of the plastics optical element which presents said refractive-index distribution, said maintenance process in the temperature region of predetermined within the limits, and said cooling process by batch processing.
[0026] According to the aforementioned configuration, it can realize to the usual shaping facility only by addition of the general-purpose facility in which temperature management of a thermostat etc. is possible, and, therefore, cost reduction is made that there is little plant-and-equipment investment, and installation tooth-space reduction is made.

[0027] The manufacture approach of the plastics optical element concerning claim 6 of this invention is a thing according to claim 2, and is characterized by performing continuously the forming cycle of the plastics optical element which has said refractive-index distribution and said heating process, said maintenance process in the temperature region of predetermined within the limits, and said cooling process.
[0028] According to the aforementioned configuration, performance monitoring of real time is made and it succeeds in the correspondence at the time of poor quality arising quickly.
[0029] Heat treatment processing of the predetermined time in the temperature region of predetermined within the limits is performed, and the plastics optical element concerning claim 7 of this invention is characterized by reducing internal refractive-index distribution.
[0030] According to the aforementioned configuration, internal refractive-index distribution is reduced, refractive-index distribution becomes small, and a highly precise optical property is obtained.
[0031] The plastics optical element concerning claim 8 of this invention is a thing according to claim 6, and is characterized by forming said plastics optical element from thermoplastic amorphous plastic material.
[0032] According to the aforementioned configuration, the refractive-index distribution inside a plastics optical element is easily reduced at an annealing process.
[0033]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained. Explanation of the main point of the manufacture approach of the plastics optical element of this invention obtains configuration precision and the good mold goods of a birefringence with injection molding etc. first. In addition, the method of obtaining these mold goods will not ask a class, if configuration precision and the good mold goods of a birefringence are obtained. Therefore, conventional injection compression molding or other conventional fabricating methods are applied. However, since the resin near the metal mold wall surface is rapidly cooled inside these mold goods as mentioned above, refractive-index distribution has arisen in it.
[0034] Then, these obtained mold goods are passed through maintenance and the process of further cooling in the temperature region of heating and predetermined within the limits out of metal mold, that is, the refractive-index distribution inside a lens is reduced by passing through an annealing process.
[0035] It explains, while the gestalt of operation is shown below. Drawing 1 is the diagram showing the refractive-index distribution in 1 operation gestalt of the plastics optical element manufactured by the manufacture approach of the plastics optical element concerning this invention. The plastics optical element shown here is applied to the image formation lens used for said light-scanning equipment.
[0036] First, with injection molding, configuration precision is good and obtains the mold goods which do not almost have a birefringence. The annular polyolefine which is thermoplastic amorphous plastic material as an example was used for use resin. These mold goods were heated from a room temperature to the temperature of the annealing conditions 1 - conditions 4, mostly, fixed time amount maintenance was carried out at this temperature, and annealing processing cooled to an after [this] room temperature was performed.
[0037] The measurement result of the refractive-index distribution after annealing is shown in the refractive-index distribution Cv1-Cv4 in drawing 1 , and Table 1. In addition, the dotted-line curve in drawing shows the refractive-index distribution Cv50 before annealing as a comparison. The location z of drawing 1 meets in the direction of the z-axis shown by said drawing 6 .
[0038] Table 1 expresses the refractive-index distribution after annealing on the annealing conditions 1 (glass-transition-temperature Tg-25 degree C of resin), the annealing conditions 2 (Tg-20 degree C), the annealing conditions 3 (Tg-10 degree C), and the annealing conditions 4 (directly under [Tg]) with the ratio to refractive-index distribution deltan in front of annealing. Furthermore, the result which receives each of the annealing conditions 1-4 supports the refractive-index distribution Cv1-Cv4.
[0039]

[Table 1]
アニール条件と屈折率分布の関係（保持時間１ｈｒ）

条件	屈折率分布
アニール前	Δｎ
条件１（Ｔｇ－２５℃）	０．３３Δｎ
条件２（Ｔｇ－２０℃）	０．２３Δｎ
条件３（Ｔｇ－１０℃）	０．１７Δｎ

[0040] By performing annealing processing processing to mold goods from this drawing and this table shows that refractive-index distribution is decreasing greatly. Moreover, the image formation location carried out image formation to the predetermined location (a design value near [for example,]), so that refractive-index distribution was small, as a result of not finding most effects on the lens side configuration by having annealed on the annealing conditions 1-4 and evaluating an optical property.
[0041] Thus, by this invention, heat treatment processing of the predetermined time in the temperature region of predetermined within the limits is performed, and the plastics optical element by which internal refractive-index distribution was reduced is realized. Moreover, as plastic material, it is desirable to use thermoplastic amorphous plastic material as mentioned above.
[0042] Although the temperature of temperature heated and held is so large that it is high at the glass transition temperature of -25 degrees C or more of resin, above glass transition temperature, a possibility that the effect on a lens side configuration may become large has the refractive-index distribution reduction effectiveness of an annealing process, and it is not desirable. Moreover, the temperature heated and held is set up lower than the glass transition temperature of -25 degrees C, and although the same refractive-index distribution reduction effectiveness is acquired also by extending the time amount to hold, it is not desirable if productivity is taken into consideration. By setting the temperature heated and held as within the limits from the glass transition temperature of -25 degrees C of resin to directly under [glass-transition-temperature], refractive-index distribution reduction effectiveness with the holding time sufficient [at least less than 2 hours] is acquired, and productivity is not spoiled. Moreover, about the temperature heated and held and the time amount to hold, it is desirable from the field of productivity that it is decided according to the requirement specification of a lens that they will be as low temperature as possible and short time amount.
[0043] Drawing 2 is the process explanatory view of 1 operation gestalt of the manufacture approach of the plastics optical element by this invention. Moreover, drawing 3 is the diagram showing the temperature-change profile of the annealing process in the manufacture approach of drawing 2 .
[0044] As shown in drawing 2 and drawing 3 , the plastics optical element which is fabricated by shaping equipment PF, and presents refractive-index distribution to the interior, and is below in predetermined temperature (for example, room temperature) is heated within annealer PA, and is raised to the temperature region TZ of predetermined within the limits, subsequently to the temperature region TZ of this predetermined within the limits only predetermined time tr is held, and it cools this the back. Flattening of the internal refractive-index distribution is carried out by this annealing process.
[0045] Moreover, in drawing 2 , if a certain amount of approach of carrying out the number stock and passing by batch processing at an annealing process collectively is adopted for mold goods, there is an advantage that it can carry out only by adding the general-purpose facility in which

temperature management of a thermostat etc. is possible to the usual shaping facility.
[0046] Drawing 4 is the process explanatory view of other operation gestalten of the manufacture approach of the plastics optical element by this invention. As shown in this drawing, in continuation annealer PA2, annealing processing is continuously carried out for the mold goods picked out from the metal mold of shaping equipment PF. This approach can supervise quality on real time, and has the advantage which can perform quickly correspondence at the time of poor quality arising.
[0047] Furthermore, the manufacture approach immediately supplied to an annealing process with an elevated-temperature condition is also possible, without cooling to a room temperature, after picking out the mold goods obtained with injection molding etc. from metal mold in order to raise productivity. The profile of the temperature change in such an annealing process is shown in drawing 5 . That is, the mold goods of an elevated-temperature condition picked out from metal mold are put into an annealer, temperature is dropped to the predetermined within the limits temperature TZ, only the predetermined holding time tr2 is held, and it cools after this, and considers as a product.
[0048] As mentioned above, as the example has described, by this plastics optical element manufacture approach, a fault which was stated on the trouble of the conventional technique is cancelable, a cost rise is very small and manufacture of a highly precise plastics optical element is attained.
[0049]
[Effect of the Invention] As explained in full detail above, the manufacture approach of the plastics optical element concerning claim 1 of this invention Heat the plastics optical element in below predetermined temperature, and it is raised to the temperature region of predetermined within the limits. Since predetermined time maintenance is carried out in the temperature region of this predetermined within the limits and it considers as the configuration subsequently cooled, internal refractive-index distribution is reduced, therefore, by low cost, high degree of accuracy, i.e., configuration precision, is good, and it can obtain a birefringence and a plastics optical element with small refractive-index distribution.
[0050]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacturing technology of plastic lens ****** especially used for light-scanning systems, such as a copying machine, facsimile apparatus, and laser beam printer equipment, about the manufacturing technology of a highly precise plastics optical element and ******.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Since surface type-like precision and a precision high to an internal birefringence were required of optical elements, such as a lens and prism, its glass thing was conventionally main. However, the thing made from plastics has been increasing in recent years for the reasons of excelling which are the degrees of freedom and mass-production nature of a configuration. There is improvement in the forming technique which makes possible that the resin ingredient of a low birefringence property was developed as this reason and the mold goods whose configuration precision is a low birefringence well.
[0003] Conventionally, as a resin ingredient used for an optic, although the polycarbonate and the acrylic were main, the birefringence of the polycarbonate was large and, on the other hand, the use range was restricted from the reasons of an acrylic having a problem in absorptivity. However, recently it is low absorptivity as an optic application, and the resin ingredient of a low birefringence property was developed, and application became possible. As such a resin ingredient, there are for example, Nippon Zeon Zeonex, APEL made from the Mitsui petrochemistry, etc.
[0004] Moreover, by using the injection compression molding which fills up resin with low voltage also as forming technique, and applies compression through the whole metal mold or an ON piece, configuration precision is good and the mold goods of a low birefringence came to be obtained. Since it is above, it is in the inclination to continue till recent years and for plastics-ization of an optical element to be promoted further.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The manufacture approach of the plastics optical element which starts claim 1 of this invention as explained in full detail above, Since heat the plastics optical element in below predetermined temperature, it is raised to the temperature region of predetermined within the limits, predetermined time maintenance is carried out in the temperature region of this predetermined within the limits and it considers as the configuration subsequently cooled, internal refractive-index distribution is reduced, therefore, by low cost, high degree of accuracy, i.e., configuration precision, is good, and it can obtain a birefringence and a plastics optical element with small refractive-index distribution.
[0050] Since the manufacture approach of the plastics optical element concerning claim 2 of this invention carries out predetermined time maintenance of the plastics optical element in the elevated-temperature condition immediately after shaping in the temperature region of predetermined within the limits and considers it as the configuration cooled to the appropriate back, internal refractive-index distribution is reduced, therefore it is low cost, and high degree of accuracy, i.e., configuration precision, is good, and it can obtain a birefringence and a plastics optical element with small refractive-index distribution with sufficient productivity.
[0051] The manufacture approach of the plastics optical element concerning claim 3 of this invention can reduce internal refractive-index distribution, without worsening the configuration precision of a plastics optical element, since it considers as low temperature and only 25 degrees C of upper limits are constituted from glass transition temperature of the plastic material which uses the minimum of the temperature region of said predetermined within the limits indicated by claims 1 or 2 as a glass transition temperature.
[0052] The manufacture approach of the plastics optical element concerning claim 4 of this invention can reduce internal refractive-index distribution, without spoiling productivity, since the time amount held in the temperature region of said predetermined within the limits indicated by claims 1 or 2 constitutes in less than 2 hours.
[0053] Since the manufacture approach of the plastics optical element concerning claim 5 of this invention considers the heating process of a publication, the maintenance process in the temperature region of predetermined within the limits, and a cooling process as the configuration performed by batch processing by claim 1, it is realizable only by adding the general-purpose facility in which temperature management of a thermostat etc. is possible to the usual shaping facility. Consequently, there is little plant-and-equipment investment, and cost reduction is possible, and an installation tooth space can also be lessened.
[0054] Since the manufacture approach of the plastics optical element concerning claim 6 of this invention is considered as the configuration which performs continuously the forming cycle of a publication, a heating process, the maintenance process in the temperature region of predetermined within the limits, and a cooling process by claim 2, it can supervise quality on real time and is effective in the ability to perform quickly correspondence at the time of poor quality arising.
[0055] Since the plastics optical element concerning claim 7 of this invention is the configuration that heat treatment processing of the predetermined time in the temperature region of predetermined within the limits was performed, and internal refractive-index distribution was

reduced, and refractive-index distribution is small, a highly precise optical property is obtained. Moreover, an optical design becomes very easy in order to carry out image formation to the image formation location for which it asked from the lens side configuration and the refractive index of a resin ingredient.
[0056] The plastics optical element concerning claim 8 of this invention is a thing according to claim 6, and since it moreover consists of thermoplastic amorphous plastic material, it is effective in the ability to reduce easily the refractive-index distribution inside a plastics optical element at an annealing process.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As mentioned above, although it continues till recently and the optical element of the birefringence property that configuration precision is good and low came to be obtained, the refractive-index distribution inside the optical element after fabrication was large, and there was a problem that it was still inadequate for realizing satisfactory optical-character ability, to a highly precise optical element therefore especially.
[0006] This is explained using drawing 6 thru/or drawing 9 . Drawing 6 is the ** type perspective view of the image formation plastics optical element (image formation lens) used for light-scanning equipments, such as a laser beam printer. Moreover, drawing 7 is a type section Fig. within a perpendicular flat surface at the y-axis of light-scanning equipment. As shown in both drawings, image formation of the beam which penetrated the image formation lens Op in the transparency direction Xv, and it converged after the beam which carried out outgoing radiation from the light sources, such as semiconductor laser, was made parallel by the collimator lens and the deviation scan was carried out by the rotating polygon Plm is carried out on the scan layer Scnf-ed.
[0007] it is shown in drawing 7 -- as -- configuration precision -- good -- low -- even if it uses a birefringence image formation lens, the lens configuration, the image formation location (design value) f1 for which it asked from the refractive index (it is assumed inside a lens that it is homogeneity) of a resin ingredient, and the location gap have produced the actual image formation location f2.
[0008] When this cause was analyzed, it became clear that it was because the refractive-index distribution to which a refractive index becomes small exists as were shown in drawing 8 , and the refractive index by the side of a lens Op front face was large and it went in the center of lens Op. According to this refractive-index distribution, the operation which a beam emits conversely will work, therefore an image formation location will become far, and an image formation location gap will take place.
[0009] Next, the mechanism which refractive-index distribution produces inside Lens Op is explained. If injection restoration of the resin of a melting condition is carried out into metal mold when such a lens is fabricated with injection molding, the part which touched the low-temperature metal mold wall surface will be cooled momentarily. Drawing 9 is an analysis value which shows the temperature change of the resin in metal mold.
[0010] As compared with a temperature fall near the metal mold wall surface (i.e., a resin periphery part) being steep, the temperature fall of a resin central part is loose. Where the high pressure the time of injection restoration and in early stages of dwelling is cost, it will quench near the metal mold wall and will be in a solid state. Therefore, as for a lens front face, a consistency becomes large. However, since the pressure is declining when the center section of the lens will be cooled and it will be in a solid state, the interior of a lens becomes a low consistency. Consequently, a consistency is as large as a lens front face, and a consistency becomes small, so that it goes to the interior. Since there is high functionality in a consistency and a refractive index, the refractive-index distribution to which a refractive index becomes small will arise, so that a lens Op front face like drawing 8 has a large refractive index and therefore goes in the center.

[0011] As mentioned above, resin may be rapidly cooled near the metal mold wall surface as a main cause which refractive-index distribution produces. Then, the temperature distribution in mold goods were made small by performing annealing to hot metal mold, after carrying out injection restoration of the resin, and the method of obtaining the small lens of refractive-index distribution by this was proposed. However, according to this fabricating method, since the molding cycle was very long, it was a fault that cost becomes very high.

[0012] Furthermore, the lens configuration was specified and the approach refractive-index distribution used a small field was tried. As such a conventional technique, there are some which were indicated with the light-scanning equipment of JP,08-201717,A. According to this technique, it is prescribed in the travelling direction thickness (t: the direction dimension of a x axis of drawing 7) of a beam, and the height (h: the direction dimension of the z-axis of drawing 7) of it and a perpendicular direction that it is set to h/t>2 by the lens configuration. It plans that make small the temperature distribution at the time of resin cooling (the direction of the z-axis) in the field which a beam penetrates, and this limited part makes a gap of an image formation location small by enlarging h using refractive-index distribution being small.

[0013] However, since this approach is increasing the part outside the field which a beam's does not penetrate, i.e., a service area, it needs to lengthen a cooldown delay the increment in the required amount of resin, and for surface sink prevention, and serves as cost quantity.

[0014] Moreover, there are some which were indicated in JP,09-49976,A as an approach of performing the optical design which expected refractive-index distribution. This is the approach of Lycium chinense amending the increase (configuration amendment) of the refraction by the side of the scan layer-ed of an image formation lens, and the design value of an image formation location to a rotating-polygon side in the image formation location gap by refractive-index distribution of an image formation lens, and carrying out image formation of the beam on a scan layer-ed. However, when there was fault on shaping etc., for example and there was modification of a process condition since it determines correction value after this approach evaluated the lens which carried out fabrication where a process condition is fixed, it had to change correction value and had the fault that re-manufacture of a mirror plane piece was needed.

[0015] Moreover, since it is necessary to change correction value for every cavity in the case of the metal mold of picking, only the number of cavities will need to produce much programs for processing. Therefore, there was a fault of becoming cost quantity, by the fault that the number of shaping tries increases very much, the increment in the mirror plane piece production number, etc.

[0016] It was made in order that this invention might solve the trouble in the above conventional techniques, and high degree of accuracy, i.e., configuration precision, is good at low cost, and it aims at offering the manufacture approach to a birefringence and a plastics optical element with small refractive-index distribution.

[Translation done.]

* NOTICES *

MEANS

[Means for Solving the Problem] In order to solve said technical problem, the manufacture approach of the plastics optical element concerning claim 1 of this invention The process which presents refractive-index distribution to the interior, heats the plastics optical element in below predetermined temperature, and is raised to the temperature region of predetermined within the limits, It is characterized by providing the process which carries out predetermined time maintenance, and the process cooled in the appropriate back in the temperature region of said predetermined within the limits, carrying out said each process in above order, and reducing internal refractive-index distribution.
[0018] According to the aforementioned configuration, internal refractive-index distribution is reduced, therefore, high degree of accuracy, i.e., configuration precision, is good, and a birefringence and a plastics optical element with small refractive-index distribution are manufactured by low cost.
[0019] The manufacture approach of the plastics optical element concerning claim 2 of this invention is characterized by providing the process which carries out predetermined time maintenance of the plastics optical element in the elevated-temperature condition immediately after shaping which presents refractive-index distribution to the interior in the temperature region of predetermined within the limits, and the process cooled in the appropriate back, carrying out said each process in above order, and reducing internal refractive-index distribution.

[0020] According to the aforementioned configuration, a highly precise plastics optical element is manufactured by low cost and the sex from Takao.
[0021] The manufacture approach of the plastics optical element concerning claim 3 of this invention is characterized by being a thing according to claim 1 or 2, and being beyond temperature with the temperature region of said predetermined within the limits lower 25 degrees C than the glass transition temperature of the plastic material to be used, and being within the limits below glass transition temperature.
[0022] According to the aforementioned configuration, internal refractive-index distribution is reduced, without spoiling the configuration precision of a plastics optical element.
[0023] The manufacture approach of the plastics optical element concerning claim 4 of this invention is a thing according to claim 1 or 2, and time amount held in the temperature region of said predetermined within the limits is characterized by being the range of less than 2 hours.
[0024] According to the aforementioned configuration, internal refractive-index distribution is mitigated for high productivity, without spoiling the configuration precision of a plastics optical element.
[0025] The manufacture approach of the plastics optical element concerning claim 5 of this invention is a thing according to claim 1, and is characterized by performing said heating process of the plastics optical element which presents said refractive-index distribution, said maintenance process in the temperature region of predetermined within the limits, and said cooling process by batch processing.
[0026] According to the aforementioned configuration, it can realize to the usual shaping facility only by addition of the general-purpose facility in which temperature management of a

thermostat etc. is possible, and, therefore, cost reduction is made that there is little plant-and-equipment investment, and installation tooth-space reduction is made.
[0027] The manufacture approach of the plastics optical element concerning claim 6 of this invention is a thing according to claim 2, and is characterized by performing continuously the forming cycle of the plastics optical element which has said refractive-index distribution and said heating process, said maintenance process in the temperature region of predetermined within the limits, and said cooling process.
[0028] According to the aforementioned configuration, performance monitoring of real time is made and it succeeds in the correspondence at the time of poor quality arising quickly.
[0029] Heat treatment processing of the predetermined time in the temperature region of predetermined within the limits is performed, and the plastics optical element concerning claim 7 of this invention is characterized by reducing internal refractive-index distribution.
[0030] According to the aforementioned configuration, internal refractive-index distribution is reduced, refractive-index distribution becomes small, and a highly precise optical property is obtained.
[0031] The plastics optical element concerning claim 8 of this invention is a thing according to claim 6, and is characterized by forming said plastics optical element from thermoplastic amorphous plastic material.
[0032] According to the aforementioned configuration, the refractive-index distribution inside a plastics optical element is easily reduced at an annealing process.
[0033]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained. Explanation of the main point of the manufacture approach of the plastics optical element of this invention obtains configuration precision and the good mold goods of a birefringence with injection molding etc. first. In addition, the method of obtaining these mold goods will not ask a class, if configuration precision and the good mold goods of a birefringence are obtained. Therefore, conventional injection compression molding or other conventional fabricating methods are applied. However, since the resin near the metal mold wall surface is rapidly cooled inside these mold goods as mentioned above, refractive-index distribution has arisen in it.
[0034] Then, these obtained mold goods are passed through maintenance and the process of further cooling in the temperature region of heating and predetermined within the limits out of metal mold, that is, the refractive-index distribution inside a lens is reduced by passing through an annealing process.
[0035] It explains, while the gestalt of operation is shown below. Drawing 1 is the diagram showing the refractive-index distribution in 1 operation gestalt of the plastics optical element manufactured by the manufacture approach of the plastics optical element concerning this invention. The plastics optical element shown here is applied to the image formation lens used for said light-scanning equipment.
[0036] First, with injection molding, configuration precision is good and obtains the mold goods which do not almost have a birefringence. The annular polyolefine which is thermoplastic amorphous plastic material as an example was used for use resin. These mold goods were heated from a room temperature to the temperature of the annealing conditions 1 - conditions 4, mostly, fixed time amount maintenance was carried out at this temperature, and annealing processing cooled to an after [this] room temperature was performed.
[0037] The measurement result of the refractive-index distribution after annealing is shown in the refractive-index distribution Cv1-Cv4 in drawing 1 , and Table 1. In addition, the dotted-line curve in drawing shows the refractive-index distribution Cv50 before annealing as a comparison. The location z of drawing 1 meets in the direction of the z-axis shown by said drawing 6 .
[0038] Table 1 expresses the refractive-index distribution after annealing on the annealing conditions 1 (glass-transition-temperature Tg-25 degree C of resin), the annealing conditions 2 (Tg-20 degree C), the annealing conditions 3 (Tg-10 degree C), and the annealing conditions 4 (directly under [Tg]) with the ratio to refractive-index distribution deltan in front of annealing. Furthermore, the result which receives each of the annealing conditions 1-4 supports the

refractive-index distribution Cv1-Cv4.
[0039]
[Table 1]
アニール条件と屈折率分布の関係（保持時間１ｈｒ）

条件	屈折率分布
アニール前	Δｎ
条件１（Ｔｇ－２５℃）	０．３３Δｎ
条件２（Ｔｇ－２０℃）	０．２３Δｎ
条件３（Ｔｇ－１０℃）	０．１７Δｎ

[0040] By performing annealing processing processing to mold goods from this drawing and this table shows that refractive-index distribution is decreasing greatly. Moreover, the image formation location carried out image formation to the predetermined location (a design value near [for example,]), so that refractive-index distribution was small, as a result of not finding most effects on the lens side configuration by having annealed on the annealing conditions 1-4 and evaluating an optical property.
[0041] Thus, by this invention, heat treatment processing of the predetermined time in the temperature region of predetermined within the limits is performed, and the plastics optical element by which internal refractive-index distribution was reduced is realized. Moreover, as plastic material, it is desirable to use thermoplastic amorphous plastic material as mentioned above.
[0042] Although the temperature of temperature heated and held is so large that it is high at the glass transition temperature of -25 degrees C or more of resin, above glass transition temperature, a possibility that the effect on a lens side configuration may become large has the refractive-index distribution reduction effectiveness of an annealing process, and it is not desirable. Moreover, the temperature heated and held is set up lower than the glass transition temperature of -25 degrees C, and although the same refractive-index distribution reduction effectiveness is acquired also by extending the time amount to hold, it is not desirable if productivity is taken into consideration. By setting the temperature heated and held as within the limits from the glass transition temperature of -25 degrees C of resin to directly under [glass-transition-temperature], refractive-index distribution reduction effectiveness with the holding time sufficient [at least less than 2 hours] is acquired, and productivity is not spoiled. Moreover, about the temperature heated and held and the time amount to hold, it is desirable from the field of productivity that it is decided according to the requirement specification of a lens that they will be as low temperature as possible and short time amount.
[0043] Drawing 2 is the process explanatory view of 1 operation gestalt of the manufacture approach of the plastics optical element by this invention. Moreover, drawing 3 is the diagram showing the temperature-change profile of the annealing process in the manufacture approach of drawing 2 .
[0044] As shown in drawing 2 and drawing 3 , the plastics optical element which is fabricated by shaping equipment PF, and presents refractive-index distribution to the interior, and is below in predetermined temperature (for example, room temperature) is heated within annealer PA, and is raised to the temperature region TZ of predetermined within the limits, subsequently to the temperature region TZ of this predetermined within the limits only predetermined time tr is held, and it cools this the back. Flattening of the internal refractive-index distribution is carried out by this annealing process.
[0045] Moreover, in drawing 2 , if a certain amount of approach of carrying out the number stock

and passing by batch processing at an annealing process collectively is adopted for mold goods, there is an advantage that it can carry out only by adding the general-purpose facility in which temperature management of a thermostat etc. is possible to the usual shaping facility.
[0046] Drawing 4 is the process explanatory view of other operation gestalten of the manufacture approach of the plastics optical element by this invention. As shown in this drawing, in continuation annealer PA2, annealing processing is continuously carried out for the mold goods picked out from the metal mold of shaping equipment PF. This approach can supervise quality on real time, and has the advantage which can perform quickly correspondence at the time of poor quality arising.
[0047] Furthermore, the manufacture approach immediately supplied to an annealing process with an elevated-temperature condition is also possible, without cooling to a room temperature, after picking out the mold goods obtained with injection molding etc. from metal mold in order to raise productivity. The profile of the temperature change in such an annealing process is shown in drawing 5 . That is, the mold goods of an elevated-temperature condition picked out from metal mold are put into an annealer, temperature is dropped to the predetermined within the limits temperature TZ, only the predetermined holding time tr2 is held, and it cools after this, and considers as a product.
[0048] As mentioned above, as the example has described, by this plastics optical element manufacture approach, a fault which was stated on the trouble of the conventional technique is cancelable, a cost rise is very small and manufacture of a highly precise plastics optical element is attained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the diagram showing the refractive-index distribution in 1 operation gestalt of the plastics optical element by this invention.
[Drawing 2] It is the process explanatory view of 1 operation gestalt of the manufacture approach of the plastics optical element by this invention.
[Drawing 3] It is the diagram showing the temperature-change profile of the annealing process in the manufacture approach of drawing 2 .
[Drawing 4] It is the process explanatory view of other operation gestalten of the manufacture approach of the plastics optical element by this invention.
[Drawing 5] It is the diagram showing the temperature-change profile of the annealing process in still more nearly another operation gestalt of the manufacture approach of the plastics optical element by this invention.
[Drawing 6] It is the ** type perspective view of the image formation plastics optical element in light-scanning equipment.
[Drawing 7] It is the type section Fig. (y-axis inside of a perpendicular flat surface) of light-scanning equipment.
[Drawing 8] It is a mimetic diagram explaining the refractive-index distribution inside the plastics optical element after fabrication (it watched from beam transparency).
[Drawing 9] It is the diagram showing the temperature change of the resin in the forming process in metal mold.
[Description of Notations]
deltan Refractive-index distribution before annealing
Cv1 Refractive-index distribution curve by the 1st annealing condition
Cv2 Refractive-index distribution curve by the 2nd annealing condition
Cv3 Refractive-index distribution curve by the 3rd annealing condition
Cv4 Refractive-index distribution curve by the 4th annealing condition
Cv50 Refractive-index distribution curve before annealing processing

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[Translation done.]